

Model E-530

Geiger Counter Technical Manual

Eberline

A DIVISION OF
 **Thermo
Electron**
CORPORATION



Eberline



Service Centers

CERTIFIED CALIBRATION REPAIR

Eberline Instrument Certified Calibration Call Service Center for prices.
Other Manufacturer Instrument Certified Calibration \$100.00 each
Repair Rate Above Calibration plus Parts at List Price \$60.00/h
Contractual rates are available on periodic repair and/or calibration. Contact Service Center for prices.

THREE (3) YEAR EXTENDED WARRANTY

This includes Certified Calibration plus Parts

1. Eberline Instruments, FOB Eberline Customer Service Facility \$70.00 each/quarter

MISCELLANEOUS

1. Turn Around Time:

Calibration — Five (5) working days on Eberline instruments

Repair — Twelve (12) working days on Eberline instruments, unless parts have to be ordered.

2. FOB Santa Fe, New Mexico, or West Columbia, South Carolina

3. Instruments for warranty repair, repair, or calibration must be sent to:

Customer Service
Eberline Instrument Corporation
P.O. Box 2108, Airport Road
Santa Fe, New Mexico 87501
Telephone: (505) 471-3232

Customer Service
Eberline Instrument Corporation
312 Miami Street
West Columbia, South Carolina 29169
Telephone: (803) 796-3604

4. In addition, the following Customer Service Centers are available for customers outside the United States.

Thermo Electron, Ltd.
Woolborough Lane
Crawley, West Sussex
England, RH10 2AQ
Telephone: (44) 293-544811

Safety Supply Canada
214 King Street E
Toronto, Ontario
Canada M5A 1J8
Telephone: (416) 364-3234

Prices at these locations will vary from U.S. prices. Please contact the facilities for current price and delivery information.

EBERLINE INSTRUMENTS STANDARD WARRANTY

One Year Warranty: Seller warrants to replace or repair, at its option, any products or parts thereof (excluding tubes, crystals, and batteries [tubes and crystals 90 days]) which are found defective in material or workmanship within one year from date of shipment. Seller's obligation with regard to such products or parts shall be limited to replacement or repair, FOB seller's factory or authorized repair station, at seller's option. The aforesaid warranty does not cover normal life-end failure of components and will be voided if repair has been attempted by other than seller's authorized personnel. In no event shall seller be liable for consequential or special damages, transportation, installation, adjustment, work done by customer, or other expenses which may arise in connection with such defective product or parts.

Exclusion of Warranties and Limitation of Liability: **The foregoing warranty is expressly made in lieu of any and all other warranties express or implied including the warranties of merchantability and fitness for a particular purpose. Under no circumstances shall seller be liable for any indirect, special, incidental, or consequential damages to customer or to any third party.**

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MODEL E-530

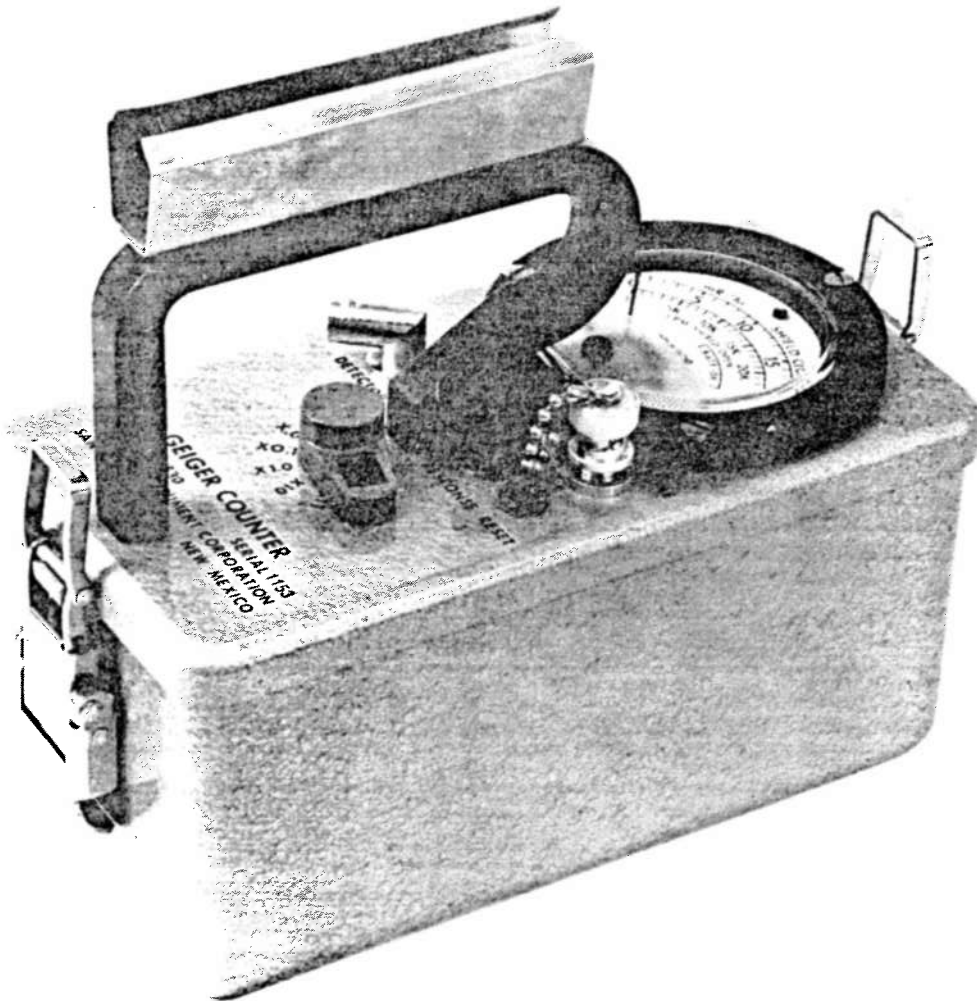


Figure 1-1. Model E-530

SECTION I GENERAL

A. PURPOSE AND DESCRIPTION

The Model E-530 Portable Geiger Counter provides an instrument with outstanding operational characteristics in a small lightweight package at an economical price. The large, ruggedized meter provides exceptional readability and linearity with a variable response time. Excellent energy response is provided by the energy compensated detector. Calibration stability results from temperature compensation and battery voltage regulation. High efficiency circuits extend the life of the two D-cell batteries. A rotary switch combines the functions of power switch, battery check and selection of one of the four sensitivity ranges. The amplifier-driven phone output may be used with headset, speaker assembly (SK-1), or external pulse counter.

Design features include: Pulse amplifier (10 mV input sensitivity), monolithic integrated circuit trigger, meter driver with variable response time, phone driver, regulated and feedback controlled high voltage supply, and individual calibration controls for each range. A single printed circuit board holds and interconnects all components resulting in a minimum number of solder joints which enhances reliability. The printed circuit board connects to the diecast cover, forming a completely operational instrument with controls and test points exposed for ease of calibration or maintenance. The instrument is splashproof and dustproof and, with its temperature stability, can be used under almost any weather condition.

B. SPECIFICATIONS

1. READOUT

a. Meter: Ruggedized, waterproof with dual scale 0-20 mR/h and 0-24k counts per minute (cpm). *BATT OK* (battery ok) limits.

b. Range: Switch controlled multipliers of 0.01, 0.1, 1.0 and 10 yield scales of 0.2, 2, 20, and 200 mR/h and 240, 2.4k, 24k and 240k cpm.

c. Linearity: Within $\pm 5\%$ of full scale ($\pm 2\%$ typical) when driven with repetitive signal. Linearity with detector depends on count rate and the dead time of the detector.

d. Response Time: Continuously variable by panel control from 10 seconds to 2 seconds, measured to 90% of final value.

e. Phone: One pulse for each event counted. Negative pulse approximately 2.5 V in amplitude; pulse width determined by range switch position.

f. Voltage Coefficient: Reading changes less than 10% with battery voltage from 3.0 to 2.0 V (new batteries to end point).

g. Saturation Level: Meter will remain at full scale on all ranges in a 1000 R/h field when the HP-270 probe is in use.

2. DETECTOR

The standard E-530 detector is the Eberline Model HP-270 energy-compensated Geiger-Mueller (G-M) hand probe with the following features:

a. G-M Tube: Thin wall (30 mg/cm²), halogen quenched.

b. Housing: Impact-resistant ABS plastic with beta (β) windows and sliding β shield.

c. Sensitivity: Approximately 1200 cpm per mR/h for ¹³⁷Cs.

d. Environmental: Temperature range, -55 °C to +75 °C. Splashproof construction.

e. Energy Response: See Figure 1-2.

A three-foot cable is provided for the hand probe.

Any Eberline 900 V G-M detector, such as the HP-190 or HP-260 thin window probes, for example, may be operated with the E-530. When an alternate detector is used, the E-530 calibration and saturation level specifications may not apply.

3. POWER SUPPLY

a. Batteries: Two D-cells held by internal captive holders.

b. Voltage Requirement: 1.6 V maximum to 1.0 V minimum per cell.

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c. Life: Variable depending on cell type, age, temperature, etc. Nominal life with new cells at room temperature for each type is: C-Zn, 300 hours; Alkaline, 500 hours; Mercury, 700 hours; Ni-Cd (single charge), 200 hours.

4. ENVIRONMENTAL

a. Weather: Splashproof by use of O-ring seals throughout.

b. Temperature: The instrument is operational from -40°F to $+140^{\circ}\text{F}$ (-40°C to 60°C) with a typical temperature coefficient of reading less than 0.1% per $^{\circ}\text{F}$. The battery type limits the low temperature perfor-

mance because of terminal voltage decrease and internal impedance increase. For prolonged operation at low temperatures the following criteria are suggested: Mercury, $+32^{\circ}\text{F}$ (0°C); C-Zn, 0°F (-18°C); Alkaline or Ni-Cd, -40°F (-40°C).

5. MECHANICAL

a. Dimensions: Approximately 4-in wide x 8-in long x 6 3/4-in high (10.2 cm x 20.3 cm x 17.1 cm), including handle.

b. Weight: Approximately 4-3/8 lb (2 kg), including C-Zn batteries and HP-270 probe.

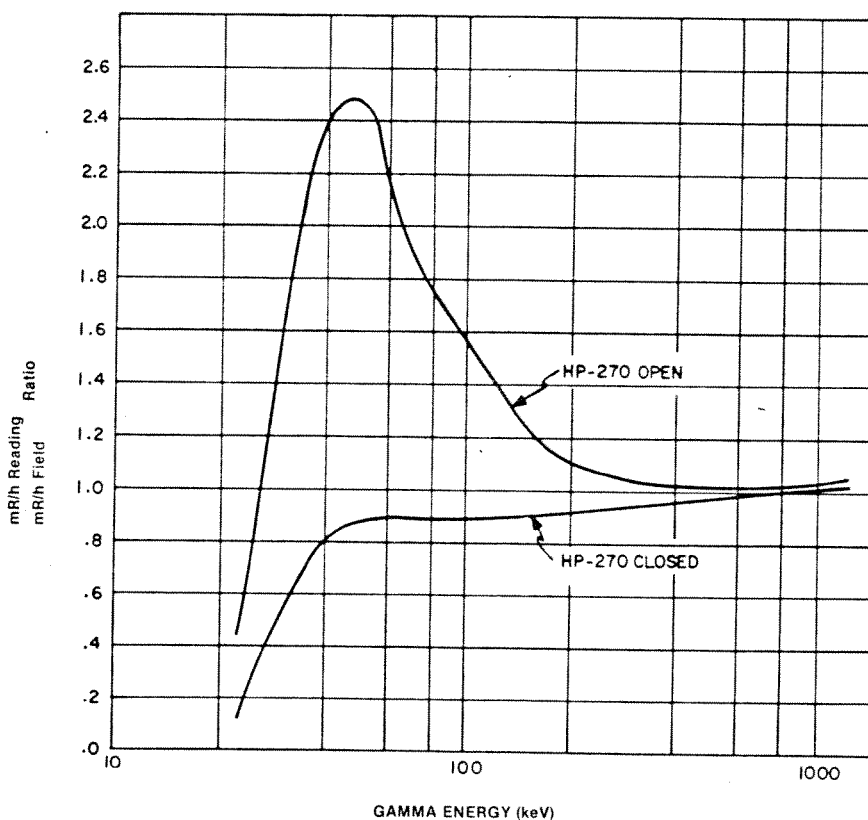


Figure 1-2. Typical Energy Response of HP-270

SECTION II OPERATION

A. DESCRIPTION OF CONTROLS AND CONNECTORS

1. EXTERNAL (See Figure 2-1)

a. Switch: Six-position rotary switch that turns instrument *OFF*, checks *BATT* condition and selects scale multipliers of 0.01, 0.1, 1.0, 10. This number must be multiplied by the meter indication to obtain the proper reading.

b. Response: Controls response time of meter to the most desirable compromise between speed and fluctuation for the particular usage.

c. Reset: Discharges integration capacitor, bringing meter reading to zero rapidly.

d. Phone: Pulse output for use with earphone, speaker or external scaler. Mating connector is BNC series coaxial.

e. Detector: Connection to hand probe. BNC series coaxial.

2. INTERNAL (See Figure 2-1)

Calibration Controls: One control for each range which individually calibrates that range to agree with the input pulse rate.

B. PREPARATION FOR USE

1. INSPECTIONS

The instrument should be checked for physical damage.

2. CONNECTIONS

Connect the probe cable to the probe connector.

C. USING THE INSTRUMENT

1. STARTING

Turn the switch to the *BATT* check position. The meter should indicate within the *BATT OK* area.

2. OPERATION CHECK

Place a check source in a repeatable position adjacent to the detector and move the switch to a range that gives an upscale reading. Note that the reading is sensitive to the position of the source. The reading may be recorded for future reference.

Push the *RESET* button and the reading should drop to zero rapidly, then climb back to source reading when the *RESET* is released. The *RESPONSE* may be adjusted to get the most desirable compromise between speed of response and meter fluctuation.

3. INTERPRETATION OF INDICATIONS

The meter reading must be multiplied by the scale factor to obtain the proper number. The fluctuation of the meter is normal and is caused by the random nature of radioactive decay.

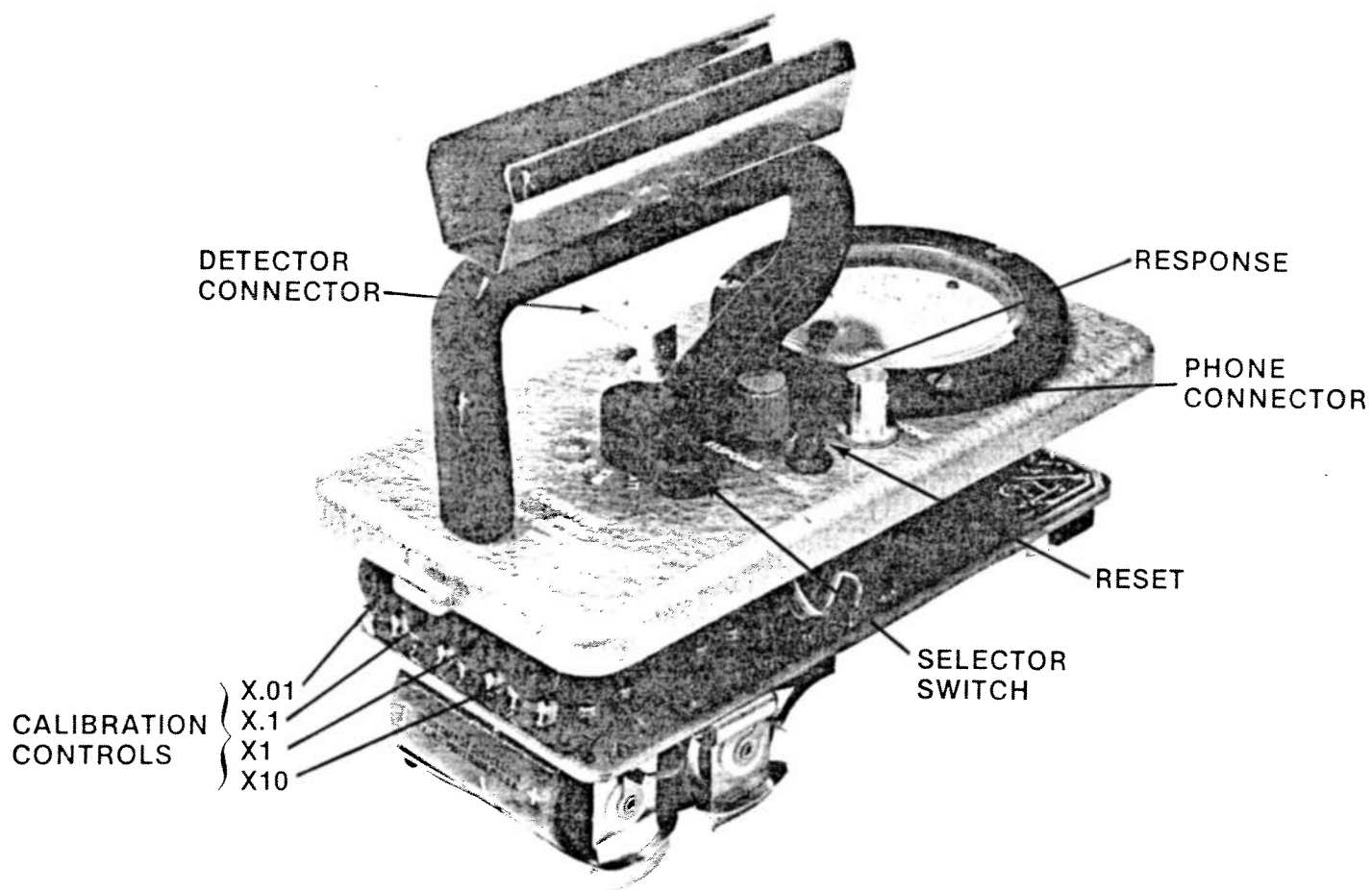


Figure 2-1. Location of Controls

SECTION III THEORY OF OPERATION

A. GENERAL

The high voltage supply develops +900 V, which is applied to the G-M tube, giving it the proper operating voltage. When radiation reacts in the G-M tube, negative pulses are generated. These pulses are coupled into the amplifier where they are amplified. They are then coupled to the trigger circuit where they are converted to standard size pulses. These standard pulses are applied to the meter driver which converts them to standard pulses of current, averages this current and drives the meter. Thus the meter deflection is proportional to the average rate of radiation at the G-M tube.

B. FUNCTIONAL THEORY (see Figures 3-1 and 6-1)

1. HIGH VOLTAGE SUPPLY

The oscillator transistor (Q1) drives T1 primary and gets its feedback from T1's red-orange winding. The voltage is stepped up by T1's secondary, rectified, filtered and applied to V1. V1 regulates at 900 V. The current through V1 is sensed by Q2, amplified, and used to control the current through Q3. The current through Q3 controls the bias level of the oscillator Q1. This tends to hold the current through V1 to a constant value regardless of battery voltage. The result of this is that power is not wasted with new batteries, just so it will function with lower voltage batteries. This greatly extends battery life.

2. AMPLIFIER

Q4 and Q5 form a feedback-controlled preamplifier which amplifies the negative pulses from the detector. The feedback enhances stability and the biasing on Q4 protects from overdrive. Q6 is biased just into cut-off so its output is near 0 V. A pulse turns it on and the resulting positive output pulse starts the trigger circuit.

3. TRIGGER

Integrated circuit A1 is connected to operate as a mono-stable multivibrator whose pulse width is controlled by the RC time constant between its pins 7 and 5. This time constant is established by the setting of S1D (scale selection) which selects a particular R and C. The calibration controls from the R for each scale, making the pulse width continuously adjustable for calibration.

When the trigger is initiated by the pulse from Q6, the output at pin 6 goes positive and holds until the predetermined time (RC) elapses.

4. METER DRIVER

The driver Q8 is normally off, so no current flows through M1. When the trigger is on, Q8 is turned on and current flows. The amount of current is determined by the voltage on the base of Q8 and R25. The length of time that current flows is determined by the pulse width of the trigger. This (current times time) forms a certain charge which is transferred to C10 for each event counted. C10 discharges through M1, yielding a certain average current dependent on the rate of input pulses. Changing the pulse width of the trigger (i.e. changing scales or calibration pot setting) changes the average current for a given input pulse rate. This allows the meter to be calibrated to read in cpm or mR/h at the detector.

The response time of M1 is controlled by the RC time constant of C10 and R27, the response control. With R27 set to low resistance the time constant is fast, and at high resistance it is slow.

5. PHONE DRIVER

Q7 amplifies and inverts the output pulse from the trigger, yielding a large amplitude negative going pulse which is capacitively coupled to the *PHONE* connector.

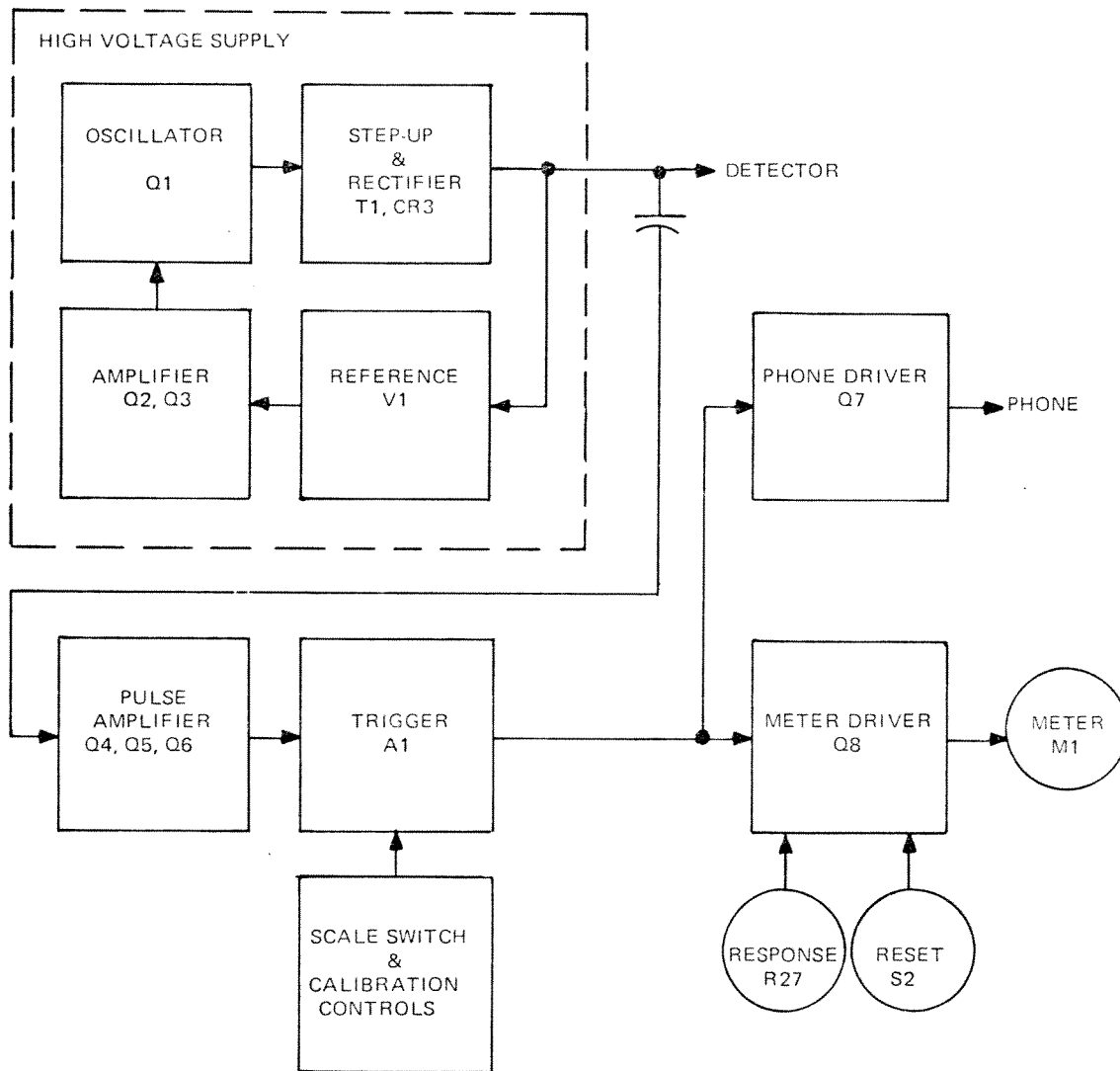


Figure 3-1. System Block Diagram

SECTION IV MAINTENANCE

A. DISASSEMBLY AND REASSEMBLY

1. BATTERIES

The batteries are secured in captive holders on the etched board. The holding straps may be removed by hand, but a small screwdriver facilitates removal. Pull the batteries from the holder. Replace by sliding batteries into holders, making certain they are centered and of the correct polarity. Replace holding straps.

2. ETCHED BOARD

The etched board and cover may be separated for troubleshooting. Proceed as follows:

a. Remove batteries to prevent electrical damage during disassembly.

b. Remove knob and mounting nut from scale switch.

c. Remove two screws that secure meter to circuit board.

d. Separate board and cover without putting undue stress on wires.

e. For troubleshooting, place jumpers from meter studs to corresponding points on board and replace batteries.

f. Reassemble in reverse order of disassembly.

B. PREVENTIVE MAINTENANCE

1. Keep the instrument clean and dry.

2. Replace batteries when their check reading is below the acceptable level.

3. Remove batteries if the instrument is to be inactive for a long period.

C. CALIBRATION

For maximum accuracy, the instrument should be calibrated under the same conditions as it will be used. Refer to section (1B), (1f) and (4b) for effects of battery voltage and temperature.

The instrument can be calibrated to either cpm or mR/h on all ranges.

1. Place the detector in a γ radiation field equal to about 3/4 scale on the meter.

2. Adjust the calibration control for the range selected until meter reading agrees with radiation field.

3. Repeat for each scale (x0.01, x0.1, x1.0 and x10).

To calibrate to cpm, proceed as follows:

1. Capacitively couple a pulse generator into the detector connector using a capacitor with a 1 kV or higher voltage rating. The pulse generator must have a negative pulse greater than 15 mV amplitude and a frequency range covering the instrument range.

2. Adjust pulse generator frequency to correspond with approximately 3/4 scale meter reading and adjust the calibration control for the range selected until meter reading agrees with the frequency.

3. Repeat for all ranges.



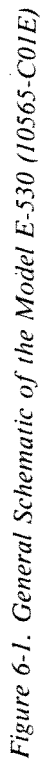
SECTION V PARTS LIST

The following table lists the electronic items incorporated in the E-530 and should contain any part necessary for normal electronic repair. Unless otherwise specified, callouts of manufacturers and manufacturers' part numbers are to be considered typical examples only. There are no restrictions against using equivalent parts with the same operating characteristics. When ordering parts from Eberline, specify model number, serial number, reference designation, value, Eberline part number, or a word description if the part has no reference designation. Eberline will automatically substitute equivalent parts when the one called out by the manufacturers' part number is not available.

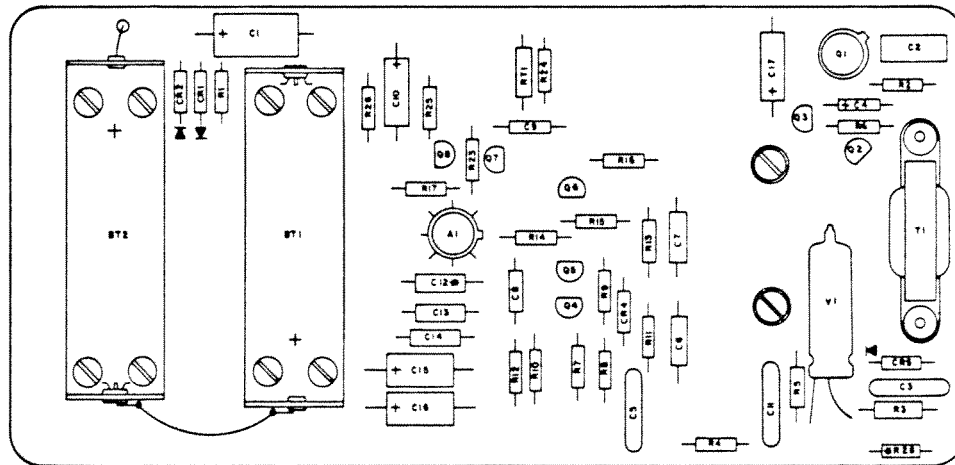
REF DESIG	PART	DESCRIPTION	MANUFACTURER AND PART NUMBER	EBERLINE PART NUMBER
A1	Integrated Circuit	RTL Dual NOR Gate, Milli watt	Motorola MC710G or better	ICRTC0810G
BT1, BT2	Battery	C-Zn, "D" cells	Eveready 1050 or equivalent	BTCZ3
C1	Capacitor	330 μ F, 20%, 6 V	Kemet K330C6	CPTA331M3D
C2	Capacitor	0.047 μ F, 20%, 50 V	GE 75F1R5A473	CPPF473P3N
C3, C5, C11	Capacitor	0.01 μ F, 1.6 kV	Sprague BL-S10	CPCE103PXV
C4, C9	Capacitor	3.3 μ F, 20%, 10 V	Kemet K3R3C10	CPTA335P3H
C6	Capacitor	0.01 μ F, 10%, 200 V	Sprague 192P-10392	CPPF103P3R
C7, C8	Capacitor	0.001 μ F, 10%, 200 V	Sprague 192P-10292	CPPF102P3R
C10	Capacitor	120 μ F, 10 V	Dickson CS13B-C127M	CPTA121M3F
C13	Capacitor	0.0018 μ F, 10%, 200 V	Sprague 192P-18292	CPPF182P3R
C14	Capacitor	0.018 μ F, 10%, 80 V	Sprague 192P-1839R8	CPPF183P3O
C15	Capacitor	0.18 μ F, 10%, 80 V	Sprague 192P-1849R8	CPPF184P3O
C16	Capacitor	1.8 μ F, 10%, 20 V	Mallory CS13-BE185K	CPTA185P3I
C17	Capacitor	33 μ F, 20%, 10 V	CS13 Case B	CPTA330M3F
CR1, CR2	Diode		1N748	CRZR1N0748
CR3	Diode	2500 PIV	Varo VA-25	CRSIVA0025
CR4	Diode		1N4148	CRSI1N4148
J1	Connector Jack	BNC (Phone)	UG-657/U	CXBN7
J2	Connector	BNC (Detector)	UG-1098/U	CXBN9
M1	Meter	0-20 μ A dc with 10472-B26 face	Triplett 321-HR Special	MTPA7 ZP10472026
Q1	Transistor	PNP	2N404	TRGP2N0404
Q2, Q3, Q4, Q5, Q7, Q8	Transistor	NPN, Silicon	2N4124	TRSN2N4124
Q6	Transistor	PNP, Silicon	2N4126	TRSP2N4126
R1, R2	Resistor	270, 5%, 1/4 W		RECC271B22
R3	Resistor	22M, 5%, 1/2 W		RECC226B23
R4	Resistor	1M, 5%, 1/4 W		RECC105B22
R5	Resistor	470k, 5%, 1/4 W		RECC474B22
R6	Resistor	330, 5%, 1/4 W		RECC331B22

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REF DESIG	PART	DESCRIPTION	MANUFACTURER AND PART NUMBER	EBERLINE PART NUMBER
R7, R24	Resistor	1k, 5%, 1/4 W	CTS type XHT201R103B, RR9167	RECC102B22
R8	Resistor	8.2k, 5%, 1/4 W		RECC822B22
R9	Resistor	15k, 5%, 1/4 W		RECC153B22
R10	Resistor	3.9k, 5%, 1/4 W		RECC392B22
R11	Resistor	3k, 5%, 1/4 W		RECC302B22
R12, R13	Resistor	6.2k, 5%, 1/4 W		RECC622B22
R14	Resistor	24k, 5%, 1/4 W		RECC243B22
R15	Resistor	27k, 5%, 1/4 W		RECC273B22
R16	Resistor	2.2k, 5%, 1/4 W		RECC222B22
R17	Resistor	2.7k, 5%, 1/4 W		RECC272B22
R19, R20, R21, R22	Potentiometer	10k		PTCC103B02
R23	Resistor	10k, 5%, 1/4 W		RECC103B22
R25	Resistor	220, 5%, 1/4 W		RECC221B22
R26	Resistor	180k, 5%, 1/4 W		RECC184B22
R27	Potentiometer (Response)	25k, 10%, 1/4 W		PTCC253B23
RT1	Sensistor	10k at 25 °C 10%		RETS103BX2
S1	Switch (Scale)		Eberline 10565-B04	SWRO34
S2	Switch (Reset)		Micro Switch 1PB5	SWPB14
T1	Transformer		Microtran M-8050 or M-7120	TFHV2
V1	Regulator Tube	900 V, 2%, T-3	Victoreen 5841	TUVR900



MODEL E-530



NOTES:

* THIS COMPONENT USED ON E-520 ONLY,
BUT MAY BE INSTALLED ON E-530

Figure 6-2. Component Layout (10557-C28)





N		QUAN.	PER.	DESCRIPTION
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This document is for Eberline in-house usage only and is subject to modification at any time. The process described herein is valid only if performed by Eberline personnel at Eberline facilities.

E	CHG.	APP.	DATE	DESCRIPTION		DATE	BY	CHK
				SHEET 2, STEP II, A. ADDED HP-270 TO PROBE LIST		10/10	727	EF

EBERLINE INSTRUMENT CORPORATION
SANTA FE, NEW MEXICO

MODEL E-530
CHECKOUT PROCEDURE

DR.				
CH'K.				
PROJ. ENG.				
APP.				

DIMENSIONAL TOLERANCES
UNLESS OTHERWISE SPECIFIED

FRAC.	DEC.	ANG.
± 1/64	X.XX ± .015	± 1/2°
	X.XXX ± .005	

ALSO USED ON	EFF. WITH



CHECKOUT PROCEDURE			MODEL E-530		10429-A66		Sheet 2 of 3	
REVISION	BY	APPROVED	DATE					
A	WJH/t	ELE	10/2/75					

SETUP AND CALIBRATE

I. ELECTRONICS CHECKOUT

- A. Connect variable low voltage supply to instrument in place of batteries. Milliammeter in series with + lead. Electrostatic voltmeter from high voltage to battery (-).
 1. With $3 \pm .05$ volts applied, battery current must not exceed 27 ma; high volts between 875 and 925.
 2. With $2 \pm .05$ volts applied, battery current must not exceed 25 ma; high voltage must not change more than 10 volts from Step 1 voltage nor drop below 875 volts.
 3. BATT check must read at line with between 1.85 to 2.2 volts applied.
- B. Connect Mini Pulser to detector connector. Battery supply at 2.5 volts.
 1. Input sensitivity must be less than 10 millivolts. (3 foot cable)
 2. Verify functioning of RESET, RESPONSE, and PHONE output.
 3. With Mini Pulser set for an on-scale reading, vary low voltage from 2.0 to 3.0 volts. Meter reading must not change more than 10%.

II. CALIBRATION

Instrument calibration should be performed with the probe the instrument is being shipped with whenever possible. If instrument is not being prepared for a shipping order, calibrate per procedure B.

B

A. HP-270, HP-177 or HP-240 PROBES

1. Calibrate X1 and X10 ranges at 3/4 of full scale in a gamma field. Calibration must be within $\pm 5\%$ of field.
2. Remove the HP-177 probe from the instrument and attach an MP-1 pulser.
 - a. Set the MP-1 to 20,000 CPM. Switch the instrument to the X1 scale and note the reading.
 - b. Switch the MP-1 to 2000 CPM and the instrument to the X0.1 scale. Adjust calibration to the point noted in Step a.



CHECKOUT PROCEDURE				MODEL E-530		10429-A66		Sheet 3 of 3	
REVISION	BY	APPROVED	DATE						
A	WJH/t	<i>ELB</i>	10/2/75						

- c. Switch the MP-1 to 200 CPM and the instrument to the X0.01 scale. Adjust calibration to the point noted in Step a.

B. ALL OTHER PROBES

1. Connect MP-1 and calibrate each range to read true CPM input at the 20K point on the meter.
2. Check linearity of X1 and X10 ranges at 4K and 10K points on the meter. Must be within $\pm 1.5K$ on meter.

III. SAMPLE CHECKS (10% of run or six (6) instruments, whichever is larger)

/ A. SATURATION

The instrument must not saturate below 1000 R/hr on any range. (Applies to HP-177, HP-240, or HP-270 Probes only)

B. LINEARITY

Check instruments in a gamma field at 1/4, 1/2, and full scale on the X100, X10, and X1 scales.

1. On the X10 scale no reading shall differ from the field by more than 15% of full scale.
2. On the X1 scale no reading shall differ from the field by more than 8% of full scale.

